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Request for grant of a patent

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Cardiff Road
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1. Your reference — 0313319.6

2. Patent application number *(The Patent Office will fill in this part)* — 10 JUN 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

   ANDREW JOHN HARSLEY
   161 QUEENSWAY
   GRANTHAM
   LINCOLNSHIRE
   NG31 9RB

   Patents ADP number *(if you know it)* — 08227037001

   If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — WASTE-REDUCING TIE STRIPS

5. Name of your agent *(if you have one)*

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   ~~161 QUEENSWAY~~
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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
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Request for substantive examination *(Patents Form 10/77)*	
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11. I/~~We~~ request the grant of a patent on the basis of this application.

Signature Date 09 JUNE, 2003

12. Name and daytime telephone number of person to contact in the United Kingdom ANDREW JOHN HARSLEY 01476 577074

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Waste-Reducing Tie Strips

Field Of Invention

The present invention relates to tie strips, for example cable ties or horticultural plant ties.

Description Of Invention
Background

Cable ties and other forms of tie strip are used to quickly and easily secure items together. Example uses include bundling cables, sealing bags or binding plants to stakes.

One conventional type of tie strip is a long thin plastic device, with an apertured head at one end, extending from which is a slimmer tail portion. On insertion of the tail portion into the aperture of the head portion, the head engages with a series of latches spaced along a tail, and thereby prevents its withdrawal. A closed loop is thus formed by the strip which may be pulled tight around target items to fasten them together.

One significant disadvantage of such a tie strip is that the tail portion pulled through the head during fitting is wasted. Only the tail portion forming the closed loop finds utility.

Another major disadvantage of said conventional tie strips is their constrictive nature. Such tie strips are readily tightened, but do not allow the enclosed items any room to grow, expand or deform.

An alternative tie strip that reduces waste is found in prior art DE 2,524,013 wherein the disclosed tie consists of a plurality of apertured cells.

But in any tie strip composed of a repetition of unit cell portions, the transverse width of the strip will always exceed the relative transverse width of the unit cells' apertures. And in order to form a closed loop it is therefore necessary to either reduce the width of the strip and/or increase the width of the apertures.

The form of tie strip described in DE 2,524,013 solves this problem by placing apertures substantially longitudinally along the strip such that these apertures are longer than the strip is wide. The strip may then be inserted through itself at any aperture point by twisting the front end of the strip through 90°. The tie can then be pulled around the target items and secured in place by a reverse twist of 90°. The unused tail portion of this tie strip can then be used again, thereby greatly reducing waste.

Alternatively, prior art US 3,438,095 uses a similar design of cell, but without the need for any twisting, relying instead on applied force and material deformation to achieve threading.

Other alternative waste-reducing tie strip concepts are found in US 3,913,178 and US 4,150,463 wherein a continuous flat strip narrows by virtue of being foldable along its longitudinal axis, and utilises punched barbs along the centre of the strip which engage with the residual apertures formed from other such punched barbs on other portions of the strip, preferentially once the tie is in a folded state.

Another alternative tie strip is found in prior art US 5,799,376. This tie is also formed from a plurality of apertured cells, but in which threading is achieved by use of bendingly deformable spring portions extending from the strip. These allows cells to expand and/or contract to facilitate passage.

This later form of tie strip not only reduces waste, but also incorporates some longitudinal expansion by virtue of the spring portions which project laterally from the longitudinal axis. The major problem with this form of tie strip is the reliance on the mechanical properties of the spring portions to correctly expand and contract laterally during the threading process and to subsequently return to a latching state following insertion.

Summary Of Present Invention

According to the present invention, an integrally formed tie strip is made from polymeric or rubberised material consisting of a plurality of cells spaced along the length of the strip wherein each cell is provided with one or more latching members and an enclosed aperture bounded by wall portions and wherein each cell can fold transversely with respect to the longitudinal axis of the strip into a saddle shape which may then additionally fold outwards to extend the width of the enclosed aperture to permit the transit of other such cells and wherein during threading or attempted withdrawal the wall portions and/or latching members of other such penetrant cells preferentially curl about their longitudinal axes thereby effecting topological deformations of the cell portions such that said deformations transform the cells into shapes that facilitate their threading and subsequent latching against other cells whether in relaxed or deformed states.

In the present invention a change in the shape of the unit cell portions is effected by the passage of a first unit cell portion through a second unit cell portion such that the second unit cell portion folds across its lateral axis into a curved double bow or saddle shape wherein further insertion of the first unit cell portion causes the deformed second unit cell portion to extend transversely thereby increasing the lateral width of the enclosed aperture to facilitate passage of the first unit cell portion.

Additionally, lateral contraction of the first unit cell portion may be effected by the curling of the bounding walls and/or latching members of the first unit cell out of the horizontal plane of the strip causing the said unit cell portion to laterally narrow as it passes through the transverse aperture of the second unit cell portion.

Subsequent to passage of the first unit cell portion through the aperture of the second unit cell portion, any elastic properties of the material may substantially restore the first and/or second cell to their original shape and serve to locate the protruding latching members of the first cell into a position that prevents its withdrawal through the second cell, thereby forming a closed loop.

Alternatively any residual tension in the loop, or attempt to withdraw the first unit cell from the second, invokes similar curling of the walls and/or latching members of the first cell into a position that impedes withdrawal from the second cell and/or induces a complementary rotation of the walls of the second unit cell portion to present a multi-dimensional configuration suitable to achieving a superior latch integrity than could be attained by the first and/or second cell in a relaxed state alone.

Additionally, tension in the strip may also effect rotation of the latching members about an axis perpendicular to the horizontal plane of the strip such that the latching members move outwards under longitudinal tension thereby increasing the lateral width of the first unit cell portion to inhibit withdrawal.

Preferentially during threading any curling of the walls and/or latching members is away from the direction of threading and towards the target items to be bound such that the latching members do not stand proud of the strip during threading and thereby do not impede passage.

During any attempted withdrawal of the first unit cell portion through the second unit cell portion the opposite should preferably be true, with the latching members curling away from the bound target items such that they engage with the wall portions of the second unit cell portion and impede removal. The walls of the second unit cell portion may be specially channelled to assist this process and ensure the curling acts in the desired direction.

Because the threading and latching system of the present invention does not rely on spring portions to effect the deformation of the cells, it can be fabricated from materials that do not have intrinsic elastic or resilient properties, for example flexible sheets of metal or plastic. However, a preferred embodiment of the invention would make use of elasticised or rubberised material to afford the tie strip longitudinal expansion and thereby protect bound items within the closed tie loop.

Furthermore it is to be noted that the present invention does not need to be folded along its longitudinal axis, nor rotated axially by 90^{o}, to be inserted through any given aperture, and the penetrant strip can thus remain longitudinally stiff when passing through the aperture of another cell.

A preferred embodiment of the invention is a thin one-part plastic strip manufactured from rubberised material and consisting of a tongue portion at the re-entrant end to facilitate easy threading, and a plurality of similarly shaped unit cell portions extending from the tongue with their respective latching members pointing substantially away from the direction of the tongue end. Each of the unit cell portions being preferably circular or elliptical in shape, with a similarly shaped aperture passing vertically through them and horn-shaped latching members projecting from either side of the cell.

Another desirable embodiment consists of a similar elliptical or circular cell design but cut from thin sheet of material such as plastic or flexible metal.

A third preferred embodiment is the addition of a shaped aperture and encompassing wall portions such that upon insertion of the strip through a cell's aperture preferential curling of the penetrant cells is effected by this channel.

It is to be noted that any embodiment of the invention could also be produced as a continuous reel with or without re-entrant tongue portions included in the design.

Description Of The Drawings

Reference will now be made to the accompanying diagrams and drawings in which:

Figure 1 shows a conventional waste-reducing tie strip utilising a plurality of cells, when in a relaxed state

Figure 2 shows a conventional waste-reducing tie strip when in a tensioned state

Figure 3 shows a conventional waste-reducing tie strip during a threading procedure

Figure 4 shows the cellular deformations occurring in conventional waste-reducing tie strips, wherein
- a) shows a relaxed cell
- b) shows a cell under longitudinal tension
- c) shows an opened-up cell during penetration of its aperture
- d) shows a narrowed cell during insertion through an aperture

Figure 5 shows a first preferred embodiment of the invention in a relaxed state

Figure 6 shows a first preferred embodiment of the invention in a tensioned state

Figure 7 shows a second preferred embodiment of the invention in a relaxed state

Figure 8 shows a second preferred embodiment of the invention in a tensioned state

Figure 9 shows a preferred technique for fitting the tie strip

Figure 10 shows a representation of the "double-bow" or saddle shape produced during the initial threading process

Figure 11 shows a representation of the "double-bow" or saddle shape opening up as the threading process advances

Figure 12 shows three stages in the threading process

Figure 13 shows the curling of the latching members during low angle threading stage

Figure 14 shows the curling of the latching members during high angle threading stage

Figure 15 shows the opposite curling effect of a suitably channelled aperture

Figure 16 shows a suitably channelled aperture to promote inwards latch curling, in a relaxed state

Figure 17 shows a suitably channelled aperture to promote inwards latch curling, in a tensioned state

Figure 18 shows the cells and latching members returned to a default position following threading

Figure 19 shows the curling of the latching members effected by an attempted withdrawal of the threaded cells

Figure 20 shows a side view of the preferred outwards curling of the latching members when the tie strip is correctly fitted around target items

Figure 21 shows a rear view of two latching members coming together when the strip is subjected to high longitudinal tension

Figure 22 shows a removal technique preferentially utilising the notch cut into the rear walls of the cell portions, together with the inward curling latches produced by this process

Detailed Description Of The Preferred Embodiments

Figure 1 portrays a portion of waste-free tie strip in a relaxed state [1] according to existing designs (e.g. prior art US 5,799,376) in which an aperture [2] is bounded by inwardly curved wall portions [3], extending from which are latching members [4].

When longitudinal tension is applied, the rear wall of each cell bends outwards [5] and the strip generally contracts transversely and extends longitudinally, as shown in Figure 2.

The side wall members are also able to bend outwards [6] and this occurs during the insertion of one cell [7] into another [8] (Figure 3). It is to be noted that in this design the inserted (penetrant) cell [7] generally contracts laterally whereas the penetrated cell generally expands laterally [8].

Subsequent to successful penetration of one cell though another, the wall portions return to an inwardly pointing state and the latching members of the inserted cell serve to prevent its withdrawal.

The full range of cellular deformations utilised in this prior art are given in Figure 4.

Now in the present invention a similarly configured tie strip is formed but with the walls of the cells [9] already in an expanded state (see Figures 5 and 7, and c.f. Figure 4c).

The cells are generally formed from an elliptical or circular ring (or annulus), with a similarly shape aperture [10] through the centre of each. One or more latching members [11] are appended to the sides of the cell.

These cells are attached one to another to form the tail of the strip, and after a suitable length may be terminated at the re-entrant end with a tongue portion [12] to assist threading.

Preferentially the tie strip is manufactured from a single piece of material such as resilient plastic (e.g. nylon, polypropylene or polyurethane), from rubber or from suitable metal (e.g. spring steel). Injection moulding or stamping from sheet is the preferred mode of fabrication. Advantageously the strips should be around 5 to 30mm wide, 1 to 5mm thick, and up to or over 500mm in length.

As with similar tie strips, the present invention undergoes a slight transverse contraction and more noticeable longitudinal extension when subjected to longitudinal tension (Figures 6 and 8). It can also be noted that the latching members [11] undergo a rotation about an axis perpendicular to the horizontal plane of the strip [13].

This lateral extension of the latching members [13] serves to impede the threading of tensioned cells through other cells' apertures, hence the latches on conventional tie strips are generally kept small. Likewise the lateral contraction of the apertures [14] also serves to impede operation, so in conventional designs the apertures are made as wide as possible and the walls as thin as possible, with a corresponding loss of strength. These problem are, however, solvable with the present invention.

In an alternative preferred embodiment of the present invention (Figures 7 and 8) a small notch [15 and 16] is cut into the rear wall of the cell on the aperture side. This important modification transforms the apertures into shaped channels that serve several purposes, as will be explained below.

Preferentially the tie strip is fitted by always inserting the tongue at the re-entrant end (if provided), through the aperture of the rearmost cell [17] (Figure 9). The whole strip can then be pulled through this cell leaving a small loop [18] around the target items [19]. In this manner the residual strip [20] can be removed and used again and again, with the tongue portion still attached, thereby greatly reducing wastage.

In order to solve the fitting problems posed by existing tie strip designs, the present invention utilises a multistage topological approach, whereby the same shape cells are made to deform in different ways depending on their part in the fitting process.

The first such stage is the insertion of one cell through the aperture of another, as characterised in Figures 10, 11 and 12. (Note that for simplicity Figures 10 and 11 show just two elliptical cells devoid of latching members, shaped aperture channels or other such features.)

In Figure 10 a penetrant first unit cell portion [21] is pressed against the aperture of a second unit cell portion [22] resulting in the folding of the second unit cell portion along the transverse axis into a saddle shape.

Continued insertion of the first unit cell portion increases this folding to a point where the side lobe portions [23] create a "double-bow" shape and then start to fold outwards (Figure 11). This causes a lateral extension of the aperture without relying on any material-dependent spring portions as described in other tie strip designs. (The effect can indeed be demonstrated with paper or card.)

If the lateral extension of the aperture is sufficient, then the whole of the penetrant unit cell portions may pass through substantially unimpeded, as shown in three stages in Figure 12.

Ancillary to this mechanism, however, is a means of contracting the penetrant cells, such that they may pass through apertures that are either narrower, or harder to deform, than would normally suffice to permit such transit. This involves curling the penetrant cells as they pass through the aperture of another cell, and it is desirable to construct the cells of the tie strip in a manner that also promotes and controls this technique, in addition to the "saddle-folding" discussed above.

When the re-entrant end of a penetrant cell [24] enters the aperture of another penetrated cell [25], the penetrant cell's latching members [26] are forced to curl over, out of the main horizontal plane of the strip. (C.f. Figure 19)

It is advantageous for the direction of the curl (up or down) to be dictated, and if the tie strip is made fully 3-dimensional (instead of a 2-dimensional shape of finite thickness), then it is possible to incorporate geometrical features on the upper and lower surfaces to so control this curling.

However, such modifications make the strip unnecessarily complicated to manufacture and force the strip to become an asymmetric product that requires a "right-way-up" to function. Additionally, it is necessary for the curling effect to switch from curl-up to curl-down at different parts of the fitting process, and this is contrary to an asymmetric design.

One simple manner of achieving this desired control without resorting to 3-dimensional

geometry, is to manually adjust the angle of penetration, as illustrated in Figures 13 and 14.

Generally, at low threading angles – such as encountered in the first stages of threading – the latching members [26] will curl outwards from the target and towards the operator (Figure 13). Whereas at steeper angles of insertion, the latching members will curl inwards [27] towards the target, and away from the operator (Figure 14). This is particularly noticeable as the loop closes in on the target, since at this stage the strip is usually pulled sharply against the rear wall of the penetrated cell, effectively breaking the back of the strip. This is illustrated in Figure 14.

It is this latter inwards direction that is most desirous during the threading stage, because then it is the relatively smooth underside that slides over the rear wall of the penetrated cell [28]. By contrast, if the latching members curl outwards (as in Figure 13) then it is they that have to slide against the rear wall, and this causes a ratcheting action that inherently requires more force from the operator to effect transit of the penetrant cells.

Accordingly, the user of such tie strips could adjust the insertion angle so that the latching members always curl inwards, and a smooth sliding condition is maintained throughout.

However, this often entails using both hands to slide the tie into position, and a superior solution is to modify the apertures of the cells to provide a specially shaped channel that promotes the correct inwards curling even at low insertion angles. Figure 15 illustrates this point in comparison to Figure 13.

At its simplest, this shaped channel involves a substantially v-shaped or u-shaped notch, whether in a tensed [29] or relaxed state [30], extending from the aperture into the rear wall of each cell (Figures 16 and 17).

In operation, this notch serves to promote the curling of the latching members because the rear wall between them is now less rigid. (Compare Figures 5 and 7.) Furthermore, the longitudinal centre of the strip is inclined to pass into this notch, compelling the latching members to curl the opposite way – i.e. away from the operator and towards the target, as is desired.

Now once the strip has been pulled tight around the target, the latching members must be placed in a location that inhibits withdrawal.

At its simplest, this can be effected by use of a resiliently deformable material, wherein the cells return to a default shape once longitudinal tension is removed. In Figure 18, for example, it is seen how this simple technique can operate, with the latching members [31] extending sideways to engage the rear wall [32] of the penetrated cell.

A more sophisticated methodology, however, is to further exploit the curling of the latching members [33] and this can be improved by a complementary upwards rotation of the rear wall of the penetrated cell [34], as illustrated in Figure 19. If the latching members are made sufficiently long they may even extend over the top of the rear wall portion, achieving an even greater strength latch. Additionally, the rotation of the latches outwards [13] of the main horizontal plane (see Figure 6) can also be utilised to improve latching strength.

Such latch curling is obtained by applying longitudinal tension in the opposite direction (i.e. trying to withdraw penetrant cells rather than thread them). Again, the additional notch [29] can greatly assist in this process since it promotes easier latch curling, and this can only be upwards because the enclosed target [35] actually prevents the latches from curling downwards. Hence the advantageous upwards curl is largely automatic at this stage (Figure 20).

A further benefit of the rear wall notch is to draw the curled latching members together into this central channel, and if the latches are sufficiently long, they may abut one another [36] when subjected to sufficient withdrawal tension (Figure 21). At this point the curling process is inhibited, and the two latches serve to reinforce one another, again increasing the overall strength of the latch. (Complete curling over of the latching members is not usually desirable, since it results in a loss of latching ability and the slipping of the tie loop back through the aperture. Sometimes, however, a controlled amount of slip can be built into the design to prevent over-tensioning from occurring.)

It can also be noted that the notch in the rear wall of the cells will help the wall to deform during this latching process. At first glance this would imply a weakness, but since the cells rely on topological deformations to function, this weakening of the rear wall can actually increase the strength of the latched tie. Without such a notch the rear wall acts just as a barrier (as in Figure 19), whereas with a notch, the rear wall can curve around the latching members of the penetrant cell, thereby increasing the contact surface area and improving the latch strength.

Additionally, the rear wall notch affords a benefit if the tie strip needs to be removed. This is usually done by re-threading the re-entrant end (with tongue if present) [37] back through the aperture of the penetrated cell [38], in the opposite direction to which the tie was originally threaded (Figure 22).

This process causes the strip to come undone, but requires adequate space in the cells' apertures to allow such a double thickness of tie strip to be threaded through it. The extra notch in the rear wall can provide this additional space if required, without greatly compromising it's other functions.

It can also be noted that because this removal technique is usually done at a steep pulling angle, the curling of the latching members [39] is inwards towards the enclosed target. This serves to make the removal process very easy, requiring little force from the operator.

* * * * *

Figure 1

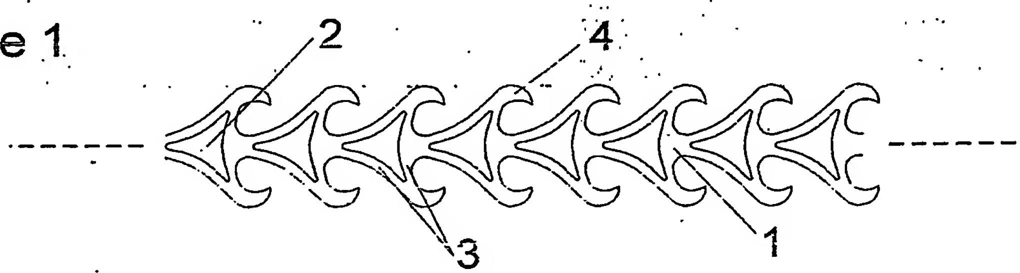


Figure 2

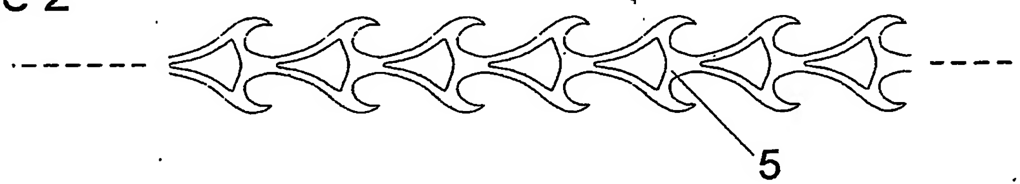


Figure 3

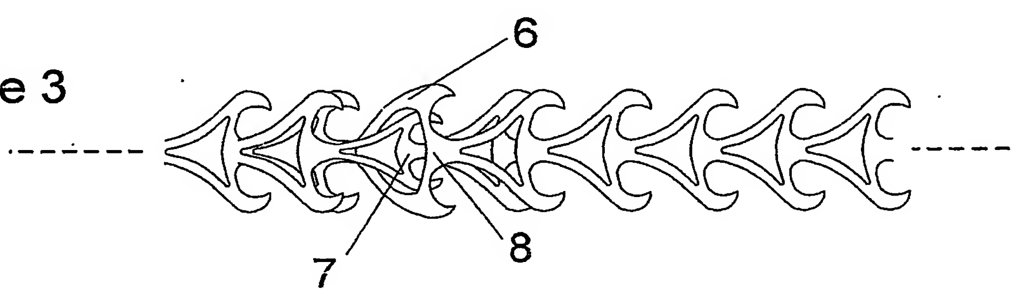


Figure 4a

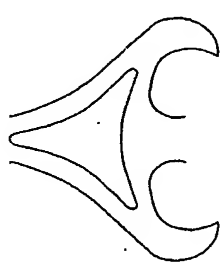


Figure 4b

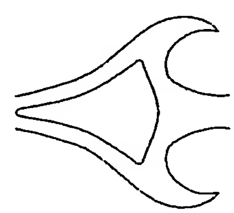


Figure 4c

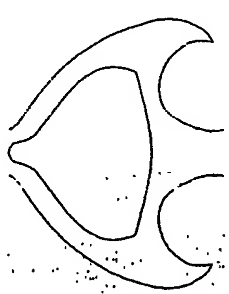


Figure 4d

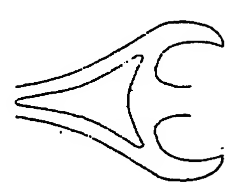


Figure 5

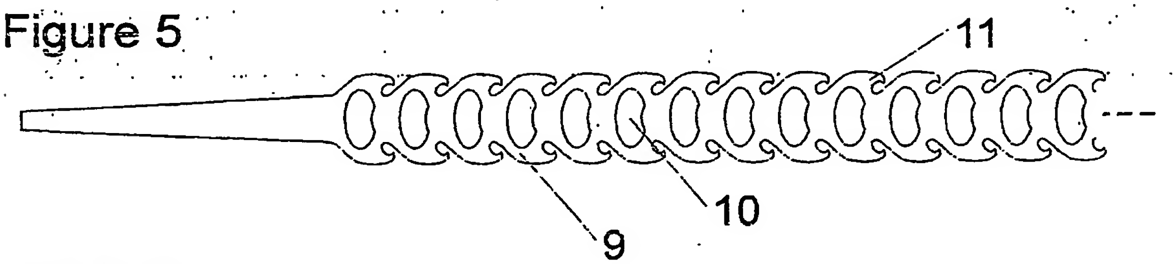


Figure 6

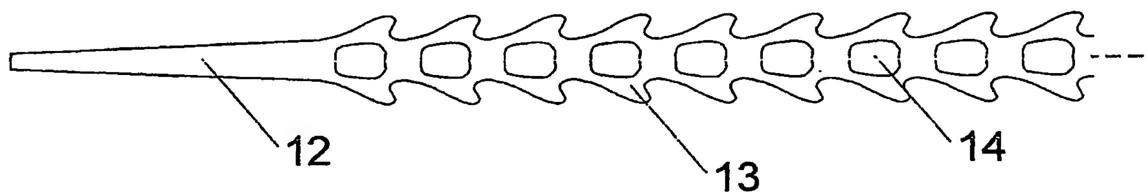


Figure 7

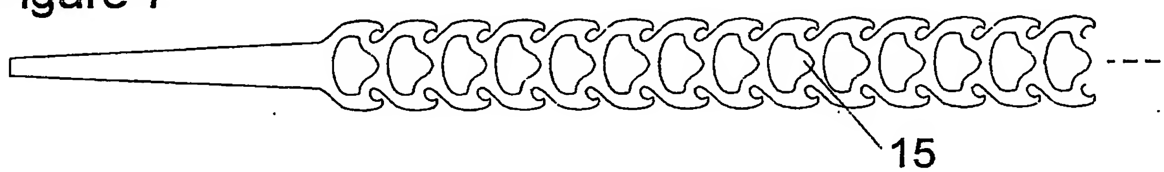


Figure 8

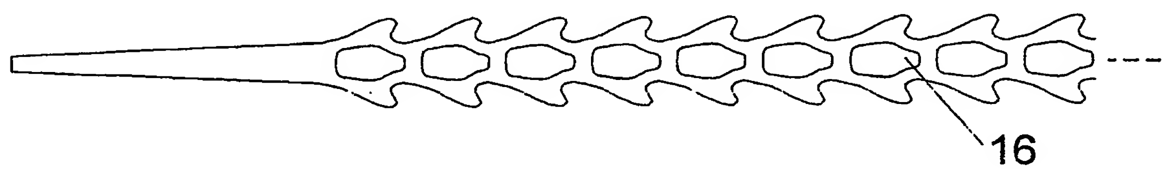


Figure 9

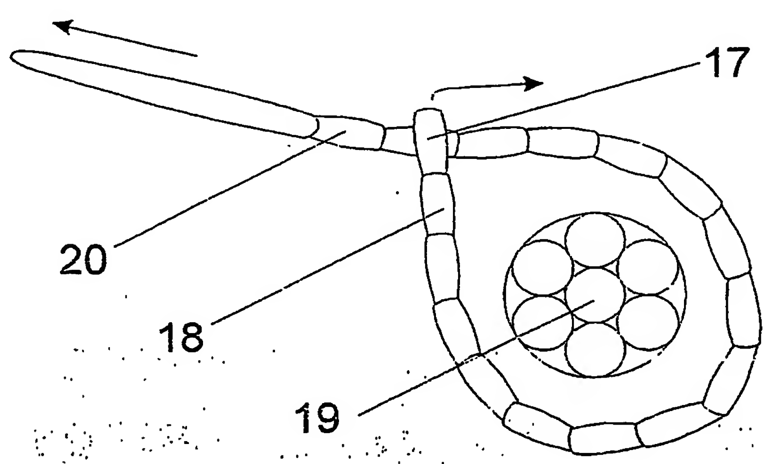


Figure 10

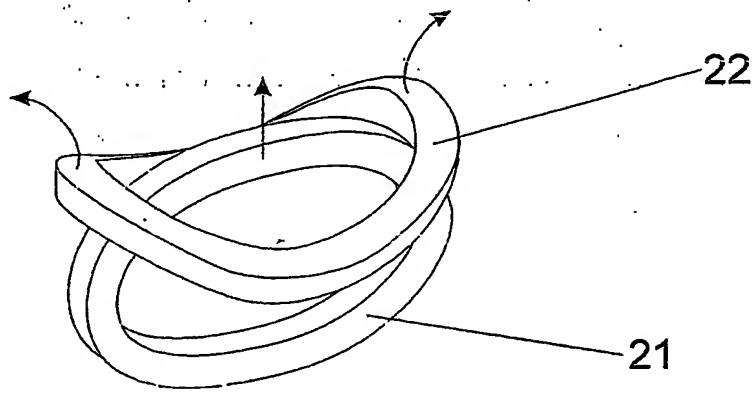


Figure 11

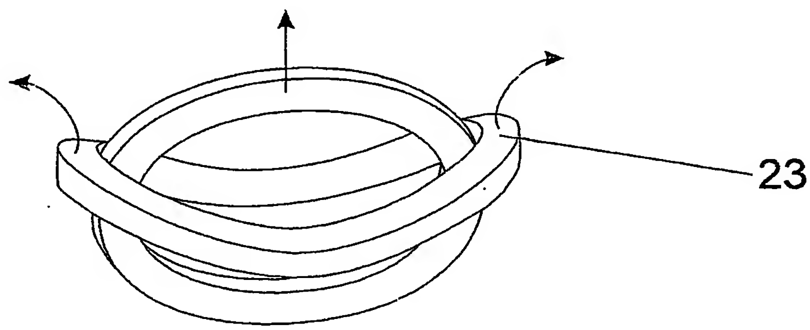


Figure 12

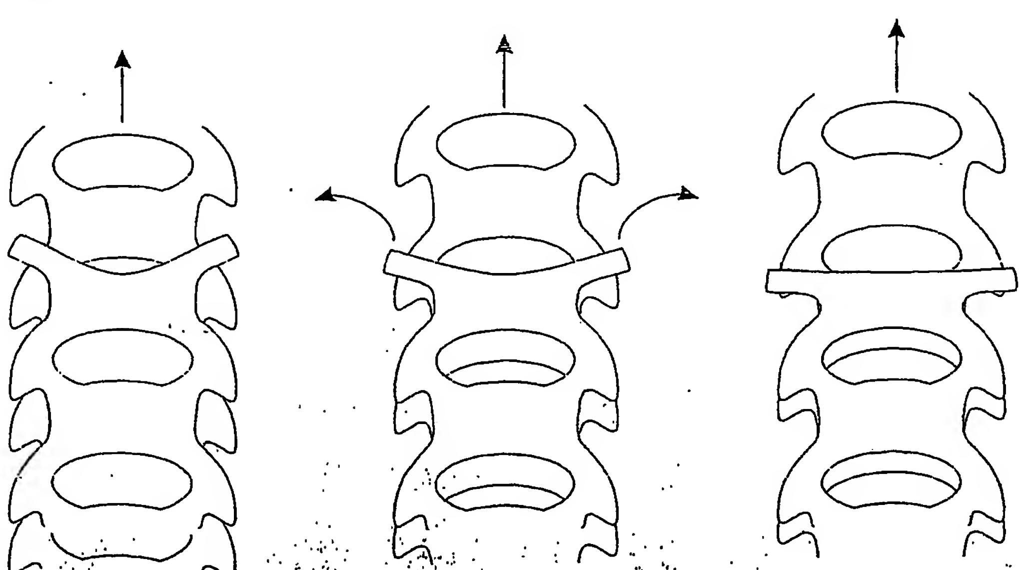


Figure 13

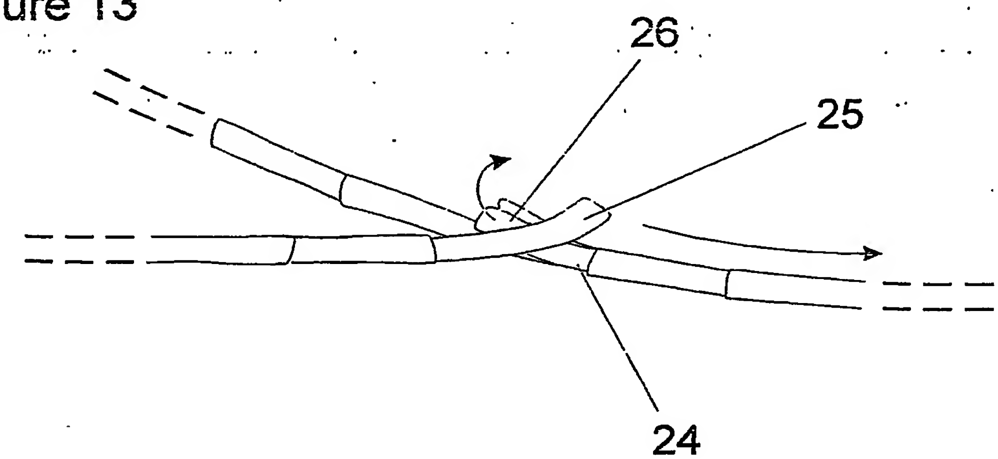


Figure 14

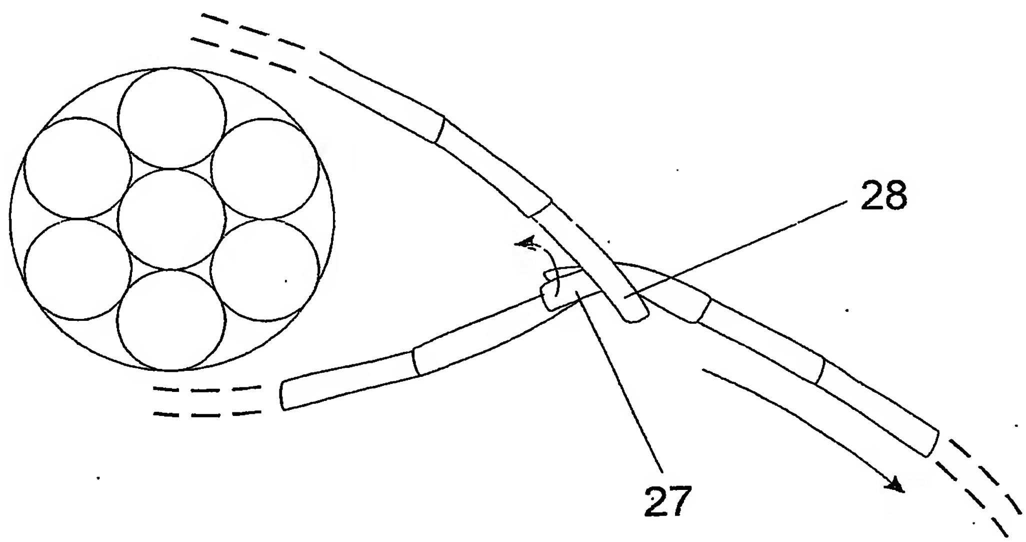


Figure 15

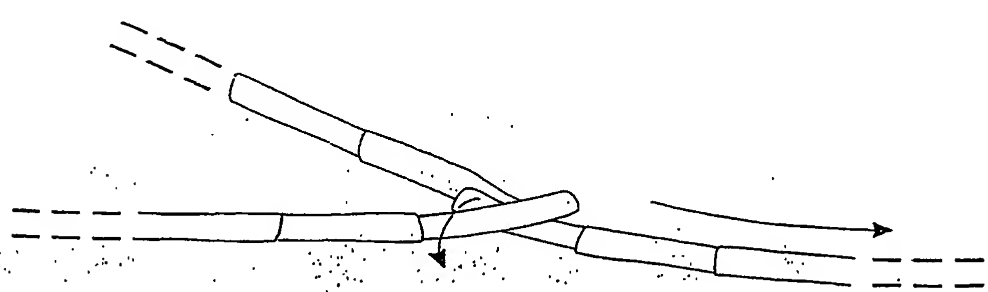


Figure 16

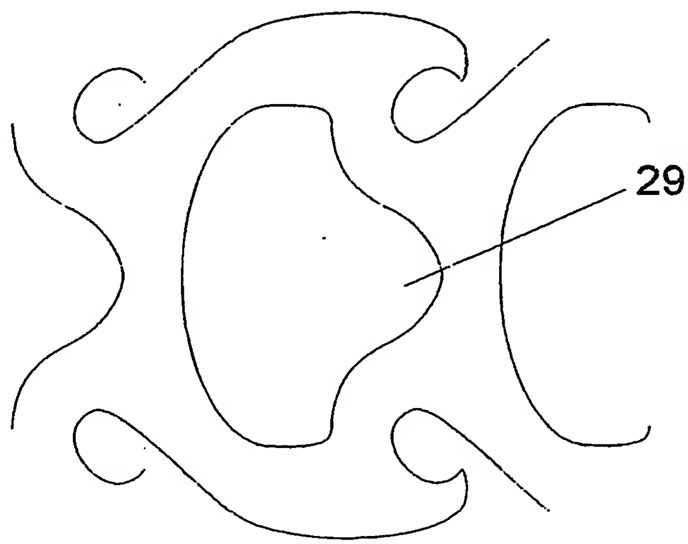


Figure 17

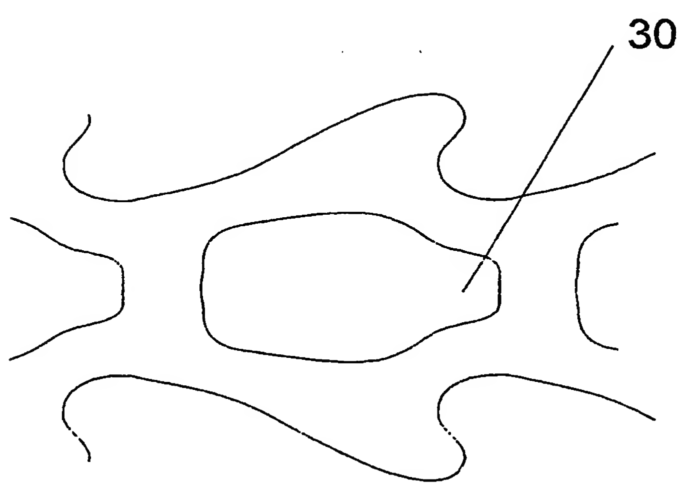


Figure 18

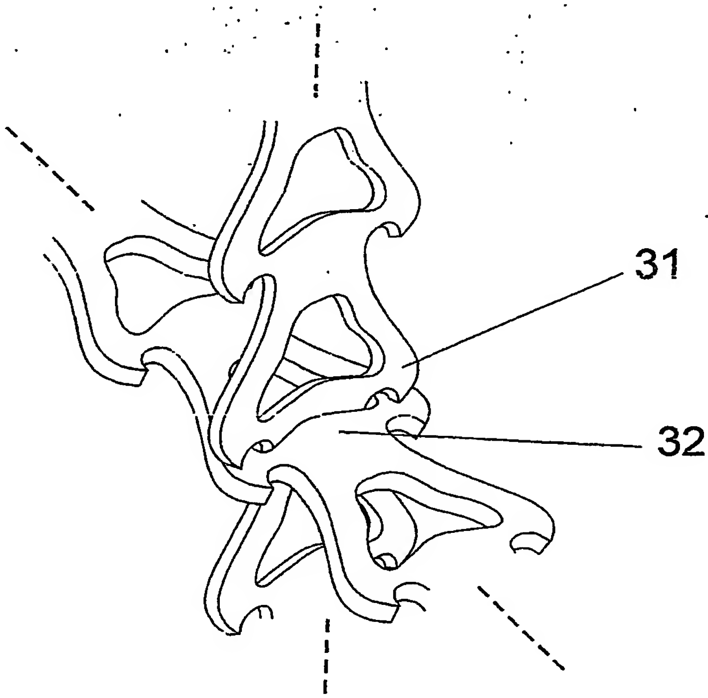


Figure 19

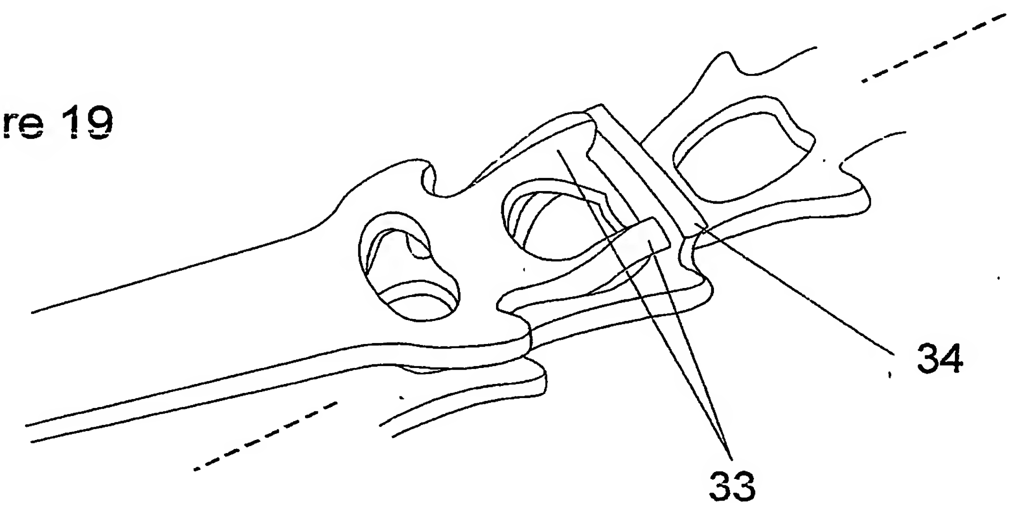


Figure 20

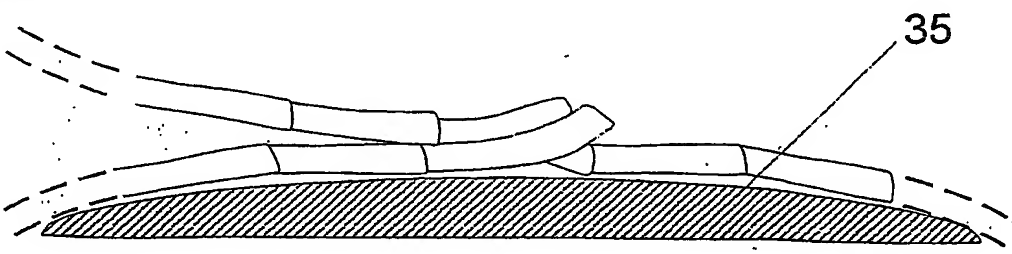


Figure 21

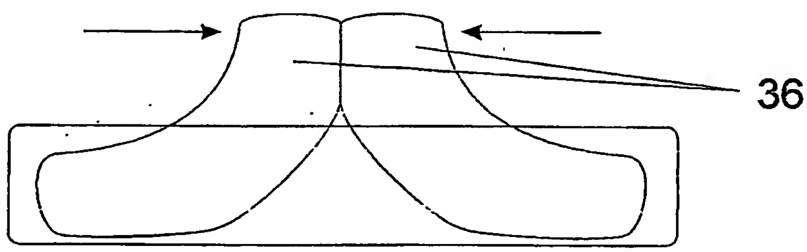
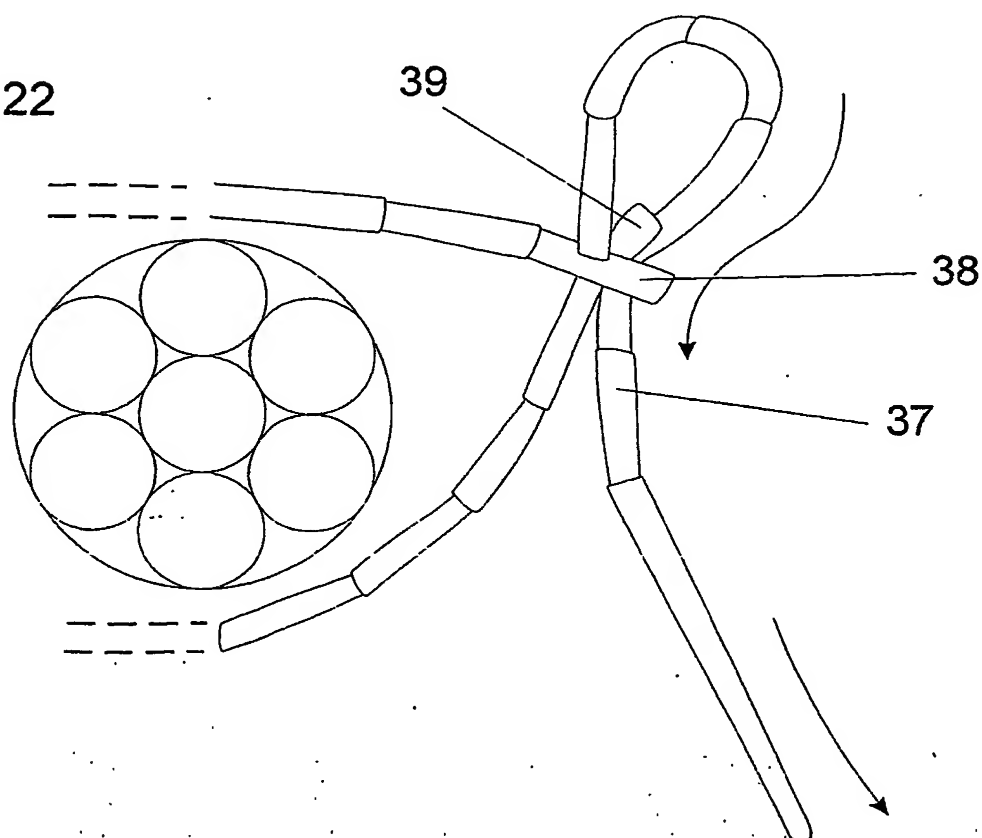


Figure 22



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